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ABSTRACT

This study reports the first use of classroom learning environment questionnaires involving students in senior high school environmental science classes. The three objectives of the study were to measure students' perceptions of aspects of their learning environment in environmental science classrooms by means of the Environmental Science Learning Environment Inventory (ESLEI), to investigate associations between students' perceptions of their classroom learning environment and students' attitudinal outcomes, and to investigate differences in student perceptions based on the students' gender and whether they were studying another science course. Results indicate that of the five aspects of environmental science students' learning environments measured in this study, student cohesion, involvement, and task orientation were found to be the most strongly associated with positive attitudinal outcomes. Contains 35 references. (DDR)

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LEARNING ENVIRONMENT, STUDENT ATTITUDES AND EFFECTS OF STUDENTS' SEX AND OTHER SCIENCE STUDY IN ENVIRONMENTAL SCIENCE CLASSES

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OBJECTIVES

This study reports the first use of classroom learning environment questionnaires involving students in senior high school Environmental Science classes. The study had three objectives. The first objective was to measure students' perceptions of aspects of their learning environment in senior Environmental Science classrooms by means of the *Environmental Science Learning Environment Inventory* (ESLEI). The second objective was to investigate associations between students' perceptions of their classroom learning environment and students' attitudinal outcomes. The third objective was to investigate differences in student perceptions based on the students' sex and whether or not they were currently studying another science course.

BACKGROUND

International research efforts involving the conceptualization, assessment, and investigation of perceptions of aspects of the classroom environment have firmly established classroom environment as a thriving field of study (Fraser, 1998; Fraser & Walberg, 1991). For example, recent classroom environment research has focused on constructivist classroom environments (Taylor, Dawson, & Fraser, 1995), computer-assisted instruction classrooms (Teh & Fraser, 1994), and teacher interpersonal behavior in the classroom (Wubbels, Creton, Levy, & Hooymayers, 1993; Kent & Fisher, 1997).

Foundations for classroom environment research were laid more than 60 years ago, when the work of Lewin and Murray assumed particular significance. Lewin (1936) introduced the formula $B = f(P,E)$ to describe human behavior *(B)* as a function of two interdependent influences, the Person *(P)* and the Environment *(E)*. Murray (1938) developed this theory to describe the concept of the personal needs of an individual (including goals and drives) and the environmental press (including stimulus, treatment, and process variables). Murray's needs-press theory led to the development of various measures of personality, but environmental measures rarely were considered in early studies.

In the past three decades, much attention has been given to the development and use of instruments to assess the qualities of the science classroom learning environment from the perspective of the student (Fraser, 1986, 1994; Fraser & Walberg, 1991), and the association between learning environment variables and student outcomes has provided a particular rationale and focus for the use of learning environment instruments. In a meta-analysis which examined 823 classes in 8 subject areas and representing the perceptions of 17,805 students in 4 nations, Haertel, Walberg, & Haertel (1981) found enhanced student achievement in classes which students felt had greater Cohesiveness, Satisfaction, and Goal Direction and less Disorganization and Friction. Other literature reviews since then have supported the existence of associations between classroom environment variables and student outcomes (Fraser, 1998).

Until about 20 years ago, research involving science students' outcomes focussed primarily on educational objectives in the cognitive domain but, in more recent times, attention has been paid to outcomes in the affective domain; the study of student

attitudes has formed a primary component of this research (Weinburgh, 1995). Shulman and Tamir (1972) suggested that affective outcomes of education are at least as important as cognitive outcomes and acknowledgement of the importance of affective outcomes is reflected in their increasing emphasis in curricula (Gardner & Gauld, 1990; Hough & Piper, 1982; Mathews, 1974).

Walberg's theory of educational productivity (Walberg, 1981, 1984) holds that there are nine factors which contribute to variance in students' cognitive and affective outcomes: student ability, age and motivation; the quality and quantity of instruction; and the psychological climate of the home, the classroom social group, the peer group outside the classroom, and the mass media (especially television viewing). Testing of the model using data collected as part of national studies has confirmed its validity in showing that student achievement and attitudes are influenced jointly by a number of factors rather than by one dominant factor (Walberg, 1986; Walberg, Fraser, & Welch, 1986). Classroom and school environment factors were found to be particularly important influences on student outcomes, even when a number of other factors were controlled. These findings are consistent with the theoretical model of Getzels and Thelen (1960), which describes the school class as a social system and suggests that group behavior can be predicted from personality needs, role expectations, and classroom environment.

Although past studies have examined associations between student attitudinal outcomes and student perceptions of the learning environment in science classes (Fraser, 1998), this study is distinctive in that it is the first to involve students specifically in Environmental Science classrooms.

Previous studies have reported sex-related differences in science students' perceptions of the learning environment (Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 1995; Lawrenz, 1987) and in students' attitudes to science (Catsambis, 1995; Friedler & Tamir, 1990; Keeves & Kotte, 1995). Therefore, in keeping with these lines of research, sex-related differences in students' perceptions of their learning environment and in their attitudinal outcomes were explored in this study.

Amongst the variety of subjects available to senior high school students in Tasmanian schools and colleges, there are several science subjects. Students may choose to study one or more science subjects, or none at all. In Environmental Science classes in Tasmania, it is common to find that 50% or more of the students are studying no other science subjects, a much higher proportion than in Biology, Chemistry, or Physics classes. As these students comprise such a major proportion of Environmental Science classes, they were treated as a subgroup in this study and their learning environment perceptions and attitudinal outcomes were compared with students studying one or more other science subjects.

DATA SOURCE

The sample was composed of Environmental Science students in two of the seven senior secondary colleges (grades 11 and 12) in Tasmania, Australia and three of the independent schools which offer senior secondary courses. A total of 100 students in seven classes were involved, representing about one-third of the total population of Environmental Science students in Tasmania in 1996.

METHOD

Students' perceptions of their learning environment were measured using the 35-item *Environmental Science Learning Environment Inventory* (ESLEI), an instrument containing scales derived from the *Science Laboratory Environment Inventory* (SLEI) (Fraser, McRobbie, & Giddings, 1993) and the instrument *What is Happening in This Class* (Fraser, Fisher, & McRobbie, 1996). Each of the 35 items in the ESLEI is assigned to one of five scales: Student Cohesion, Integration, Involvement, Material Environment, and Task Orientation, and each scale has seven items. Table 1 provides descriptive information for each scale of the ESLEI.

Table 1
Descriptive information for each scale of the ESLEI

Scale Name	Description
Student Cohesion	Extent to which students know, help and are supportive of one another.
Integration	Extent to which the laboratory activities are integrated with non-laboratory and theory classes
Material Environment	Extent to which the laboratory equipment and materials are adequate
Involvement	Extent to which students have attentive interest, share ideas, do additional work and participate in class activities
Task Orientation	Extent to which it is important to complete activities planned and to stay on the subject matter

The senior secondary Environmental Science course offered in Tasmania (Tasmanian Secondary Assessment Board, 1996) places strong emphasis on students gaining an awareness of individual values as they concern the environment, and teachers are encouraged to use class discussions to promote an understanding of values amongst students. With this in mind, a ten-item *Attitude to Class Discussions* scale was devised to gauge students' opinions of such discussions. Student attitudes also were assessed with a seven-item *Attitude to This Class* scale based on selected items from the *Test of Science-Related Attitudes* [TOSRA] (Fraser, 1981).

Using the scales of the ESLEI as independent variables, associations were computed with two outcome variables: attitude to the class and attitude to class discussions. Both

simple and multiple correlation analyses were employed, using the individual student as the unit of analysis.

Sex-related differences in students' perceptions of their learning environments were explored using a one-way multivariate analysis of variance (MANOVA) with the set of ESLEI scales as dependent variables. A second MANOVA was then used where the independent variable was whether or not a student was studying another science subject. In both cases, when Wilks' lambda criterion was found to be statistically significant ($p<0.05$), the corresponding one-way univariate analysis of variance (ANOVA) was examined for each of the ESLEI scales individually.

RELIABILITY AND VALIDITY OF THE INSTRUMENTS

Environmental Science Learning Environment Inventory (ESLEI)

When using a classroom environment instrument, it is usual to validate the instrument by the use of Cronbach's (1951) alpha coefficient as an index of internal consistency (the extent to which items in the same scale measure the same dimension). Table 2 presents alpha coefficients for the ESLEI using the individual student as the unit of analysis. Coefficients range from 0.69 to 0.77, exceeding the threshold of 0.60 given by Nunnally (1967) as being acceptable reliability for research purposes.

Another feature considered important in a classroom environment instrument is the discriminant validity of each scale of the instrument, or, the extent to which a scale measures a dimension different from that measured by any other scale. The mean interscale correlations reported in Table 2 confirm the discriminant validity of the ESLEI, indicating that each scale measures distinct (although somewhat overlapping) aspects of the classroom environment.

Table 2
Internal consistency (Cronbach alpha coefficient) and discriminant validity (mean correlation with other scales) for the ESLEI

Scale	Alpha Reliability	Mean Correlation with other scales
Student Cohesion	0.77	0.38
Integration	0.75	0.30
Material Environment	0.69	0.44
Involvement	0.71	0.32
Task Orientation	0.75	0.40

The sample consisted of 100 Environmental Science students in 7 classes.

The Attitude Questionnaires

This study used two attitude questionnaires entitled Attitude To This Class and Attitude To Class Discussions. Using the individual student as the unit of analysis, the alpha reliability coefficient was found to be 0.78 for the seven-item Attitude To This Class and 0.79 for the ten-item Attitude To Class Discussions, indicating that both instruments have acceptable internal consistency.

ASSOCIATIONS BETWEEN STUDENTS' PERCEPTIONS OF THEIR LEARNING ENVIRONMENT AND STUDENT OUTCOMES

In order to investigate associations between students' perceptions of learning environment and students' attitudinal outcomes, the data were analyzed using both simple and multiple correlation analyses. Table 3 reports the simple correlation (r), which describes the bivariate association between an outcome and an ESLEI scale, and the standardized regression weight (β), which characterizes the association between an outcome and a particular environment scale when all other ESLEI scales were controlled.

Table 3
Associations Between ESLEI Scales and Students' Attitudinal Outcomes in Terms of Simple Correlations (r) and Standardised Regression Coefficients (β)

Scale	Strength of Environment-Outcome Association			
	Attitude to Class		Attitude to Class Discussions	
	r	β	r	β
Student Cohesion	0.34**	0.21	0.35**	0.17
Integration	0.09	-0.05	0.02	-0.12
Involvement	0.33**	0.16	0.38**	0.28*
Material Environment	0.17	0.05	0.12	0.01
Task Orientation	0.20*	0.05	0.20*	0.06
Multiple Correlation, R	0.37**		0.42**	

*$p < 0.05$ **$p < 0.01$ n=100

The multiple correlation (R) data reported in Table 3 indicate statistically significant ($p<0.01$) associations between students' perceptions on the set of learning environment scales and attitudinal outcomes. Simple correlation (r) figures indicate that three scales of the ESLEI, namely, Student Cohesion, Involvement, and Task Orientation, were

significantly related to student attitudinal outcomes. The beta weights show that one of these associations, that between Involvement and Attitude to Class Discussions, retained its significance in a more conservative multivariate test with all other ESLEI scales controlled.

EFFECTS OF STUDENTS' SEX ON PERCEPTIONS OF THE LEARNING ENVIRONMENT AND ON ATTITUDINAL OUTCOMES

Sex-related differences were explored for the ESLEI using a one-way multivariate analysis of variance (MANOVA) with the set of ESLEI scales as dependent variables and with sex as the independent variable. When Wilks' lambda criterion was found to be statistically significant ($p<0.05$), the corresponding univariate analysis of variance (ANOVA) was examined for each of the ESLEI scales individually.

Table 4 presents the scale means and standard deviations for male and female students' responses to the ESLEI. Sex differences in scale means also are shown in Table 4; a negative sign indicates that the scale mean for females was higher than the scale mean for males. The data presented in Table 4 indicate statistically significant sex-related differences in students' perceptions of their learning environment, with females perceiving greater levels of Student Cohesion, Integration, Task Orientation, and Involvement, and a more favorable Material Environment. These findings are in line with several previous studies which have revealed that females generally hold more favorable perceptions of their classroom environments than do males in the same classes (e.g., Fisher, Fraser, & Rickards, 1997; Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 1995).

Table 4
Sex Differences in Students' Responses to the ESLEI

Scale	Scale Mean			Standard Deviation	
	Male	Female	Difference	Male	Female
Student Cohesion	3.53	3.93	-0.38**	0.64	0.56
Integration	3.59	3.85	-0.26*	0.64	0.53
Involvement	3.77	4.04	-0.27**	0.46	0.46
Material Environment	3.82	4.35	-0.53**	0.57	0.42
Task Orientation	3.57	3.83	-0.26*	0.63	0.44

*$p < 0.05$ **$p < 0.01$ n=100

In order to explore sex differences in students' attitudinal outcomes, another one-way multivariate analysis of variance (MANOVA) was performed with the two attitudinal outcome measures as dependent variables and with sex as the independent variable. Mean scores and standard deviations calculated for each outcome are presented in Table 5.

Table 5
Sex Differences in Students' Attitudinal Outcomes

Outcome	Mean			Standard Deviation	
	Male	Female	Difference	Male	Female
Attitude To This Class	3.71	3.72	-0.01	0.58	0.47
Attitude To Class Discussions	3.85	3.90	-0.05	0.52	0.56

n=100

Table 5 indicates that no significant sex differences were found in Environmental Science students' attitudinal outcomes. These results contrast strongly with the significant sex differences found in students' perceptions of their learning environment. However, previous studies have indicated that such sex-related differences are less pronounced in biology than in other science subjects such as chemistry and physics (Husén, Fägerlind, & Liljefors, 1974; Keeves & Kotte, 1995; Lawrenz, 1987; Murphy, 1991; Tamir, 1987; Young & Fraser, 1994) and the Environmental Science course taught in Tasmania is more closely aligned in content and delivery with Biology than with Chemistry or Physics.

A COMPARISON OF SCIENCE AND NON-SCIENCE STUDENTS' PERCEPTIONS OF LEARNING ENVIRONMENTS AND ATTITUDINAL OUTCOMES

When responding to the Environmental Science Learning Environment Inventory (ESLEI), students were asked to indicate which, if any, other science subjects they were curently studying in addition to Environmental Science. In order to compare science and non-science students' perceptions of their learning environment in Environmental Science classes, a one-way multivariate analysis of variance (MANOVA) was performed with the set of ESLEI scales as dependent variables and with involvement/non-involvement in other science courses as the independent variable.

Table 6 provides scale means and standard deviations for each scale of the ESLEI for science and non-science students, and indicates the magnitude of the difference between scale means. It is clear indicates that students currently studying another science subject perceive significantly higher levels of Student Cohesion and a more favorable Material Environment than do students not currently studying another science subject.

Table 6
Differences in Science and Non-Science Students' Responses to the ESLEI

Scale	Scale Mean			Standard Deviation	
	Science	Non-Science	Difference	Science	Non-Science
Student Cohesion	3.88	3.63	0.25*	0.51	0.68
Integration	3.84	3.66	0.18	0.46	0.66
Involvement	3.93	3.90	0.03	0.36	0.55
Material Environment	4.24	4.01	0.23*	0.44	0.61
Task Orientation	3.74	3.69	0.05	0.51	0.57

*$p < 0.05$ n=100

A one-way multivariate analysis of variance (MANOVA) with the two attitudinal outcomes as dependent variables enabled comparison of science and non-science students' attitudinal outcomes. The results of this analysis, depicted in Table 7, indicate that Environmental Science students currently studying another science subject hold significantly more positive attitudes to their class and to class discussions than do non-science students in the same classroom.

Table 7
Differences in Science and Non-science Students' Attitudinal Outcomes

Outcome	Mean			Standard Deviation	
	Science	Non-science	Difference	Science	Non-science
Attitude To This Class	3.87	3.61	0.26*	0.42	0.56
Attitude To Class Discussions	4.11	3.72	0.39**	0.46	0.55

*$p < 0.05$ **$p < 0.01$ n=100

CONCLUSION

This study has confirmed the reliability and validity of the Environmental Science Learning Environment Inventory and the reliability of the two attitudinal instruments when used specifically with senior high school Environmental Science students.

Of the five aspects of Environmental Science students' learning environments measured in this study, Student Cohesion, Involvement, and Task Orientation were found to be most strongly associated with positive attitudinal outcomes.

Results of previous studies were replicated in that female students were found to perceive a more positive learning environment than did males. The magnitude of these differences is not large (between a half and one standard deviation) but the differences consistently show that females perceive their learning environment more positively than do males. Despite these differences in student perceptions, significant sex differences were not apparent in attitudinal outcome measures.

The sex-related differences reported indicate that male and female students perceive aspects of their learning environment in different ways. This has important implications for teachers wishing to change aspects of the classroom environment in order to optimise student outcomes because particular changes might be advantageous to male students but not to female students, or vice versa.

Students studying another science subject were found to perceive some aspects of their Environmental Science classroom environment in a significantly more positive way than students not studying another science subject, and to have more positive attitudes. It is possible that students currently studying another science subject feel more confident about their abilities in Environmental Science because some of the scientific concepts which they encounter are already familiar to them and this is reflected in their positive attitudes to their learning environment. These findings are of significance to teachers of Environmental Science in that they identify a subgroup of students within a class who would benefit from classroom activities and teacher-student interactions designed to promote more positive perceptions and attitudes.

Whilst a number of previous studies have examined science students' perceptions of their learning environments, this study is distinctive in that it is the first to involve students specifically in Environmental Science classes. A particular value of this kind of study is that it identifies differing perceptions and outcomes amongst subgroups of students, providing teachers with important information that could help them to improve the quality of the teaching and learning process. Furthermore, results indicate that some aspects of the learning environment in Environmental Science classrooms are associated with students' attitudinal outcomes and suggest that favorable student attitudes could be promoted in classes where the students perceive more cohesion amongst students, a greater degree of student involvement in classroom activities, and a higher level of task orientation. Whilst an improvement in students' attitudinal outcomes is desirable for its own sake, it is possible that more positive student attitudes will be reflected in higher achievement outcomes (Freedman, 1997; Schibeci & Riley, 1986), particularly if achievement is measured by student classwork rather than by end-of-year examinations and tests (Germann, 1988).

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